# SPECIFICATION

# BOBBIN CHANGER APPARATUS FOR SEWING MACHINE

## Technical Field

The present invention relates to a bobbin changer apparatus for automatically replacing a bobbin case having accommodated therein a lower thread bobbin to be mounted in a rotary hook of a sewing machine.

## Background Art

Lower thread change devices are arranged to, when a bobbin, contained in a bobbin case mounted in a rotary hook supported on a rotary hook base, has run out of a lower thread, automatically replace the empty bobbin case with a new bobbin case containing a bobbin with a sufficient lower thread wound thereon, and such lower thread change devices have been known as bobbin changers. In Japanese Patent Application Laid-open Publication No. 2000-157774, there is disclosed a multi-head sewing machine equipped with a plurality of machine heads, where a bobbin changer is provided for each of the machine heads (i.e., for each of the rotary hook bases) and drive mechanisms of the individual bobbin changers are drivable via a same or common drive source.

In the known bobbin changers, a bobbin stock section (or bobbin replacing or changing cassette) is disposed on a portion of a sewing table closer to a human operator (i.e., adjacent to a front edge of the sewing table), and a transfer mechanism is provided to reciprocally transfer a bobbin grasping device (or bobbin chuck mechanism) between the rotary hook

supported on the rotary hook base located beneath the machine head disposed adjacent to the rear edge of the sewing table and the bobbin stock section. The bobbin stock section (or bobbin changing cassette) is equipped with a plurality of bobbin cases and delivers or receives a bobbin case to or from the bobbin changer. Namely, when a thread wound on a lower thread bobbin mounted in the rotary hook base has run out, the bobbin grasping device is moved, via the transfer mechanism, to the rotary hook in response to a lower thread runout detection signal, takes out, from the rotary hook, the bobbin case having the empty bobbin contained therein, then moved, via the transfer mechanism, to the bobbin stock section with the taken-out bobbin case grasped by the device, and then delivers the bobbin case to an empty bobbin stock position of the bobbin stock section. After that, the bobbin stock section is rotated through a predetermined angle to allow the bobbin grasping device to takes out a new bobbin case, containing a bobbin with a sufficient lower thread wound thereon, from another bobbin stock position of the bobbin stock section. Then, the bobbin grasping device is moved, via the transfer mechanism, to the rotary hook with the taken-out new bobbin case held by the device and places the new bobbin case in the empty rotary hook. Bobbin change or replacement is automatically carried out generally in accordance with such an operational sequence.

With such bobbin changers, the human operator only has to perform operation for retrieving an empty bobbin case from the bobbin stock section provided adjacent to the front edge of the sewing table and replenishing or resupplying the bobbin stock section with a new bobbin case containing a bobbin having a sufficient lower thread wound thereon. Thus, the bobbin changers allow the human operator to perform necessary operation with considerable ease. Where such a bobbin changer is not used, the human

operator has to get into under the sewing table and manually change bobbin cases in the rotary hook on the hook base, which is very cumbersome. Therefore, in large-size industrial sewing machines, such as multi-head type sewing machines, (not only ordinary sewing machines but also embroidery sewing machines), the bobbin changers of the aforementioned type are becoming indispensable in order to achieve an enhanced efficiency of sewing operation. However, with the conventional bobbin changers, there is still a room and demand for improvement.

In the bobbin changer disclosed in the above-mentioned No. 2000-157774 publication, for example, a guide plate for guiding the movement of the bobbin grasping device has a linear first guide groove, and a second groove having orientation-changing slanted portions near opposite ends thereof. By being guided by the slanted portions of the second groove, the orientation of a chuck section of the bobbin grasping device can be changed at each end of a transfer stroke of the grasping device. Namely, the transfer mechanism (i.e., guide plate) has integrally incorporated therein mechanisms for changing the orientation of the chuck section at the opposite ends of the transfer stroke.

As well known in the art, the sewing machines come in variety of sizes depending on, for example, the range to be embroidered, and the distance from the rotary hook base to the front edge of the sewing table, i.e. from the rotary hook to the bobbin stock section, also differs depending on the size of the sewing machine. Thus, guide plates of various types (sizes) would be required which correspond to different distances from the rotary hook to the bobbin stock section. With the aforementioned conventional technique, where the guide plate has integrally incorporated therein the mechanisms for changing the orientation of the chuck section at the opposite ends of the

transfer stroke, it is necessary to separately make guide plates, having integrally incorporated therein the mechanisms for changing the orientation of the chuck section at the opposite ends of the transfer stroke, in various sizes and constructions suited for various types of sewing machines, which tends to take a lot of time and labor in manufacturing of component parts and therefore result in high cost.

Generally, in large-size sewing machines, a front section of the sewing table is dividable and thus detachable when the sewing machine is to be transported; this is for reducing the size of the machine in packed form and facilitating carry-in and carry-out of the machine to and from a building. Because the guide plate of the bobbin changer, fixed to the underside of the sewing table, extends from the front section (i.e., detachable section) to the rear section (i.e., non-detachable section) of the sewing table, the bobbin changer (at least the guide plate) has to be detached first of all in order to detach the front sewing table section. Then, after the sewing machine has been carried into a building, the front sewing table section is again attached (i.e., reattached) to the body of the sewing body, and then the bobbin changer is again fixed to the underside of the sewing table. Such operation tends to take a lot of time and labor. Particularly, because positioning of the bobbin grasping device relative to the rotary hook and bobbin stock section depends on the positions of the orientation-changing mechanisms in the opposite end portions of the guide plate, position adjustment of the guide plate tends to be very time-consuming.

## Summary of the Invention

In view of the foregoing, it is an object of the present invention to provide a bobbin changer apparatus of a novel construction with various

improvements over the conventional counterparts. It is another object of the present invention to provide an easy-to-use bobbin changer apparatus which can readily deal with a difference in traveling distance of a bobbin grasping device. It is still another object of the present invention to provide a bobbin changer apparatus which can be detached and reattached without cumbersome operation even where it is applied to a dividable sewing table.

According to one aspect of the present invention, there is provided a bobbin changer apparatus for replacing a lower thread bobbin to be mounted in a rotary hook of a sewing machine, which comprises: a bobbin grasping device for grasping a bobbin case at a distal end of a chuck section; a transfer mechanism for reciprocally transferring the bobbin grasping device between the rotary hook of the sewing machine and a bobbin stock section; a first orientation change mechanism for orienting the chuck section of the bobbin grasping device toward the rotary hook of the sewing machine during transfer, by the transfer mechanism, of the bobbin grasping device toward the rotary hook; and a second orientation change mechanism for orienting the chuck section of the bobbin grasping device toward the bobbin stock section during transfer, by the transfer mechanism, of the bobbin grasping device toward the bobbin stock section. In the present invention, the first and second orientation change mechanisms are detachable from the transfer mechanism.

Because the first and second orientation change mechanisms, provided on a traveling path of the transfer mechanism, are detachable from the transfer mechanism, the first and second orientation change mechanisms of the same construction can be used even where the transfer mechanism is constructed to be able to deal with any desired reciprocal traveling distances. Thus, even where the traveling distance of the bobbin grasping device differs depending on the depth (dimension in the front-rear direction) of the sewing

table, the present invention can appropriately deal with a difference in traveling distance of the bobbin grasping device, without requiring large amounts of time and labor in making of component parts, at relatively low cost, thereby achieving an easy-to-use bobbin changer apparatus with a general versatility. Further, in the present invention, the first and second orientation change mechanisms and the transfer mechanism between the orientation change mechanisms are detachable from each other, and thus, in detachment operation to be performed in the case where the bobbin changer apparatus is applied to a sewing table of a type dividable into a front section and a main section, the first and second orientation change mechanisms can be left mounted to the main and front sections, respectively, of the sewing table with only the transfer mechanism detached. Thus, with the present invention, the detachment operation does not require a great amount of time and labor, and, in reassembly of the machine, there is no need at all for cumbersome position adjustment of the orientation change mechanisms (because the orientation change mechanisms need not be detached in the detachment operation).

According to another aspect of the present invention, there is provided a bobbin changer apparatus for replacing a lower thread bobbin to be mounted in a rotary hook of a sewing machine, which comprises: a bobbin grasping device for grasping a bobbin case at a distal end of a chuck section; a transfer mechanism for reciprocally transferring the bobbin grasping device between the rotary hook of the sewing machine and a bobbin stock section; a first orientation change mechanism for orienting the chuck section of the bobbin grasping device toward the rotary hook of the sewing machine during transfer, by the transfer mechanism, of the bobbin grasping device toward the rotary hook; and a second orientation change mechanism for orienting the chuck

section of the bobbin grasping device toward the bobbin stock section during transfer, by the transfer mechanism, of the bobbin grasping device toward the bobbin stock section, and in which the bobbin grasping device includes a moving body section linearly movable by the transfer mechanism, the chuck section pivotally supported on the moving body section, and a spring member for normally biasing the chuck section toward a predetermined neutral position. Further, in the bobbin changer apparatus of the present invention, the first orientation change mechanism orients the distal end of the chuck section toward the rotary hook against a biasing force of the spring member, and the second orientation change mechanism orients the distal end of the chuck section toward the bobbin stock section against the biasing force of the spring member. The bobbin changer apparatus thus arranged can achieve the superior benefit that it is possible to perform orientation control, i.e. posture control, of the chuck section with a simple construction.

As an example, the transfer mechanism may include a guide section for guiding the bobbin grasping device through transfer between the rotary hook and the bobbin stock section, and a drive section for reciprocally transferring the bobbin grasping device along the guide section. Thus, the transfer mechanism can be simplified in construction. Each of the first and second orientation change mechanisms has a slanted cam surface, and the bobbin grasping device includes a cam follower in relation to the chuck section. The chuck section may be caused to pivot to appropriately change the orientation of the distal end by the cam follower moving along the cam surface. Thus, the orientation change mechanisms in the present invention can be simplified in construction.

According to still another aspect of the present invention, there is provided a bobbin changer apparatus for replacing a lower thread bobbin to

be mounted in a rotary hook of a sewing machine, which comprises: a bobbin grasping device for grasping a bobbin case at a distal end of a chuck section; and a transfer mechanism for reciprocally transferring the bobbin grasping device between the rotary hook of the sewing machine and a bobbin stock section, and in which the bobbin grasping device comprises: an arm-grasping claw for pulling out a bobbin case arm; a drive section for causing the arm-grasping claw to pivot so as to pull out the bobbin case arm; and an arm-engaging protrusion for engaging with the bobbin case arm having been pulled out by the arm-grasping claw. Thus, the bobbin case grasping structure of the bobbin grasping device can be simplified while still ensuring reliable grasping of the bobbin case.

According to still another aspect of the present invention, there is provided a bobbin changer apparatus for replacing a lower thread bobbin to be mounted in a rotary hook of a sewing machine, which comprises: a bobbin grasping device for grasping a bobbin case by means of a chuck section; an actuator selectively performing a grasp operation to cause the bobbin case to be grasped by the chuck section when the chuck section is empty and a release operation to release the bobbin case from the chuck section grasping the bobbin case; a transfer mechanism for reciprocally transferring the bobbin grasping device together with the actuator between the rotary hook of the sewing machine and the bobbin stock section; a first cam mechanism for orienting the chuck section of the bobbin grasping device toward the rotary hook of the sewing machine during transfer, by the transfer mechanism, of the bobbin grasping device toward the rotary hook; and a second orientation change mechanism for orienting the chuck section of the bobbin grasping device toward the bobbin stock section during transfer, by the transfer mechanism, of the bobbin grasping device toward the bobbin stock section;

and a section for positioning the chuck section of the bobbin grasping device in a neutral posture in a middle portion of a transfer stroke between the first cam mechanism and the second cam mechanism. In this bobbin changer apparatus, replacement of a bobbin case having a lower thread bobbin accommodated therein is carried out by the bobbin case being taken into or released from the chuck section at a position where the chuck section contacts the rotary hook or the bobbin stock section.

## Brief Description of Drawings

Fig. 1 is a schematic view showing an example external appearance of a multi-head embroidery sewing machine employing a bobbin changer apparatus in accordance with the present invention;

Fig. 2 is a side view of the bobbin changer apparatus according to the embodiment of the present invention;

Fig. 3 is a side view, similar to Fig. 2, of the bobbin changer apparatus, which, in order to enhance the visibility, shows guide rods in shortened length and various elements in enlarged scale

Fig. 4 is a plan view showing of a bobbin chuck unit of Figs. 2 and 3 in another posture;

Fig. 5 is a view taken in a direction of arrow A of Fig. 4 and shows some elements in section;

Fig. 6 is a view showing the bobbin chuck unit in another posture as viewed in the same direction as Fig. 5;

Figs. 7(a) – 7(c) are side views extractively showing various operational states of a torsion spring of the bobbin chuck unit;

Figs. 8(a) – 8(c) are side views extractively showing various operational states of a chuck torsion spring of the bobbin chuck unit;

Fig. 9 is a side view showing detailed constructions of first and second orientation change mechanisms, which also schematically shows a movement trajectory of a roller during a series of orientation change operations;

Fig. 10 is a view schematically showing a movement trajectory of the chuck section during a series of orientation change operations;

Fig. 11 is a top plan view showing the chuck section of the bobbin chuck unit;

Fig. 12 is a top plan view showing how the chuck section grasps a bobbin case; and

Fig. 13 is a side view showing a modification of a mounting structure of the first orientation change mechanism to be provided on the side of a rotary hook of the sewing machine.

## Detailed Description of the Invention

[General External Appearance of Multi-head Embroidery Sewing Machine]

Fig. 1 is a schematic view showing an example external appearance of a multi-head embroidery sewing machine employing a bobbin changer apparatus in accordance with the present invention.

As known in the art, the multi-head embroidery sewing machine 1 at least includes a plurality of machine heads 2, rotary hook bases 5 (Fig. 2) provided beneath a main (body) sewing table 3 in corresponding relation to the machine heads 2, rotary hooks 6 (Fig. 2) provided on the individual hook bases. Extension sewing table 4 is detachably attached to a front edge portion of the main sewing table 3. Further, although not shown for simplification of illustration, an embroidery frame drive mechanism is provided on the sewing tables. Further, the bobbin changer apparatus 7 according to an embodiment of the present invention is provided for each of

the rotary hooks 6 corresponding to the machine heads 2. Although the bobbin changer apparatus 7 are not visible in Fig. 1 because they are disposed on the undersides of the sewing tables 3 and 4, only a reference numeral of the apparatus 7 is indicated in the figure. Bobbin stock sections 8 are provided, on a portion of the underside of the extension sewing table 4 closer to a human operator, in corresponding to the bobbin changer apparatus 7. Throughout the accompanying drawings, elements or portions necessary for the explanation are illustrated with illustration of elements or portions unnecessary for the explanation omitted. Thus, note that even elements not shown in the figures are provided in actual products, and that there are elements shown in some of the figures but not shown in others of the figures.

[General Setup of the Bobbin Changer apparatus 7]

Fig. 2 is a side view of the bobbin changer apparatus 7 according to the embodiment of the present invention, which shows the apparatus 7 mounted to the undersides of the sewing tables 3 and 4. Although Fig. 2 shows only one bobbin changer apparatus 7 corresponding to one set of the machine head 2 and rotary hook 6, the other bobbin changer apparatus 7 are constructed in the same manner as the one shown in the figure. Fig. 3 is a side view, similar to Fig. 2, of the bobbin changer apparatus 7, which, in order to enhance the visibility, extractively shows only the bobbin changer apparatus 7 and shows the individual elements thereof in enlarged scale; however, in the figure, guide rods 21 and 22 and endless toothed belt 25 are shown in shortened length for convenience of illustration. For those portions not clearly visible in Fig. 2, see Fig. 3.

The bobbin changer apparatus 7 includes a bobbin chuck unit 10 (bobbin grasping device) having a chuck section 11 provided at its distal end for grasping or holding a bobbin case B, a transfer mechanism 20 for reciprocally

transferring the bobbin chuck unit 10 between the rotary hook 6 and the bobbin stock section 8, a first orientation change mechanism 30 for orienting the chuck section 11 of the bobbin chuck unit 10 toward the rotary hook 6 during transfer, by the transfer mechanism 20, of the bobbin chuck unit 10 toward the rotary hook 6, and a second orientation change mechanism 30 for orienting the chuck section 11 of the bobbin chuck unit 10 toward the bobbin stock section 8 during transfer, by the transfer mechanism 20, of the bobbin chuck unit 10. As will be later described, the first and second orientation change mechanisms 30 and 40 are each separable or detachable from the transfer mechanism 20.

[Description about the Transfer mechanism 20]

The transfer mechanism 20 includes the guide rods 21 and 22 (guide section) extending in parallel with each other for guiding the bobbin chuck unit 10 to allow the bobbin chuck unit 10 linearly to move between the rotary hook 6 and the bobbin stock section 8, and a drive mechanism for reciprocally transferring the bobbin chuck unit 10 along the guide rods 21 and 22. The guide rods 21 and 22, which are each formed into an appropriate length according to a distance between the rotary hook 6 and the bobbin stock section 8 in the sewing machine, are interconnected at their opposite ends by means of faster members 23 and 24, to together constitute the guide section. In the illustrated example, a drive mechanism of the transfer mechanism 20 comprises the endless (or ring-shaped) toothed belt 25 extending along the full length of the belt guide rods 21 and 22. The endless toothed belt 25 is wound on and connects between a driving belt gear 26 and driven belt gear 27 provided near opposite ends of the guide rods 21 and 22, and the bobbin chuck unit 10 is fixed to a predetermined portion of the endless toothed belt 25 so that the chuck unit 10 can move together with the belt 25. The bobbin chuck

unit 10 fixed to the predetermined portion of the endless toothed belt 25 is detachable from the belt 25 by loosening a screw 12.

The driving belt gear 26 has a shaft borne on a predetermined portion of a first cam plate 31 constituting the first orientation change mechanism 30 and is connected coaxially with a driving gear 28. The driven belt gear 27 has a shaft borne on a predetermined portion of a second cam plate 41 constituting the second orientation change mechanism 40, and the driven belt gear 27 is freely rotatable by being driven via the driving belt gear 26. The driving gear 28 meshes with an interlocking shaft gear 29. The interlocking shaft gear 29 is mounted on a common interlocking shaft 50 that is driven to rotate via a bobbin-changing common drive motor (not shown). The common interlocking shaft 50 extends horizontally under the main sewing table 3, and the interlocking shaft gears 29 of the individual bobbin changer apparatus 7, provided in corresponding relation to the machine heads 2, are fixedly mounted on the common interlocking shaft 50. Thus, as the bobbin-changing common drive motor rotates, the common interlocking shaft 50 is rotated so that the interlocking shaft gears 29 of the individual bobbin changer apparatus 7 rotate together with the common interlocking shaft 50, in response to which the driving gear 28 in each of the bobbin changer apparatus 7 rotates and thus the driving belt gear 26 rotates to drive the endless toothed belt 25. Thus, the bobbin chuck unit 10 fixed to the predetermined portion of the endless toothed belt 25 is caused to move linearly.

[Description about the Bobbin Chuck Unit 10]

Fig. 4 is a plan view of the bobbin chuck unit 10. Whereas the chuck section 11 is shown as oriented downward in Fig. 3, it is shows as oriented horizontally rightward in Fig. 4. Fig. 5 is a view taken in a direction of

arrow A of Fig. 4 and shows some elements in section; however, only some of hatchings to indicate cross-sectional surfaces are indicated with the other hatchings omitted to avoid complexity of illustration. Fig. 6 shows the bobbin chuck unit 10 as viewed in the same direction as Fig. 5; whereas the chuck section 11 is depicted as oriented horizontally in Fig. 5, it is depicted as oriented downward in Fig. 6. In these and other figures as well, only some of hatchings to indicate cross-sectional surfaces are indicated with the other hatchings omitted to avoid complexity of illustration.

The bobbin chuck unit 10 includes a moving body 13 slidably fitted in the guide rods 21 and 22, and the chuck section 11 tiltably supported on the moving body 13 via a tilting shaft 14. As shown in Fig. 3, the bobbin chuck unit 10 is fixed to the above-mentioned toothed belt 25 with the toothed belt 25 held between the underside of the moving body 13 and a belt tightening member 15 tightened by the screw 12. The chuck section 11 includes a chuck tilting body 11a constituting the body of the chuck section 11, and a chuck mechanism provided at the distal end of the chuck tilting body 11a. The bobbin B is grasped or held by the chuck mechanism, a detailed construction for which will be later described. The chuck tilting body 11a is fixed to one end of the tilting shaft 14, the tilting shaft 14 extends through the moving body 13 and is tiltably or pivotally supported on the moving body 13, and a tilting-shaft actuating lever 16 is fixed to the other end of the tilting shaft 14 opposite from the chuck tilting body 11a. Roller 17 functioning as a cam follower is freely rotatably mounted on a distal end portion of the tilting-shaft actuating lever 16. As will be later described, as the roller 17 rolls along cam surfaces of the cam plates 31 and 41 of the first and second rotation change mechanisms 30 and 40, the tilting-shaft actuating lever 16 tilts about the axis of the tilting shaft 14, in response to which the tilting shaft 14 pivots so that

the chuck tilting body 11a and hence the chuck section 11 tilts about the tilting shaft 14.

Collar 18 is positioned around the tilting shaft 14 between the moving body 13 and the tilting-shaft actuating lever 16. By the width of the collar 18, there is formed a gap that permits passage of the cam plates 31 and 41 as will be described later. Further, a torsion spring (or helical spring) 19 is fitted over the tilting shaft 14 between the moving body 13 and the chuck tilting body 11a. Spring stop pin 191 is embedded in a predetermined position of the moving body 13. Further, a tilting-movement returning pin 192 is embedded in an end portion of the chuck tilting body 11a opposite from the chuck mechanism with the shaft 14 interposed therebetween. Figs. 3 and 6 show the torsion spring 19 in a neutral position. One end 19a of the torsion spring 19 is normally biased in a counterclockwise direction of Fig. 3, while the other end 19b of the spring 19 is normally biased in a clockwise direction of Fig. 3. The pins 191 and 192 are positioned to abut against the two ends 19a and 19b, respectively, of the torsion spring 19. Thus, in the neutral position shown in Fig. 3 or 6, the pins 191 and 192 are each held between the two ends 19a and 19b of the torsion spring 19, and an end portion of the chuck tilting body 11a having the tilting-movement returning pin 192 provided thereon is located uppermost, while the chuck mechanism provided opposite from the returning pin 192 is located lowermost. Namely, the chuck section 11 is set so that its distal end is oriented downward. Further, the roller 17 is located uppermost. Fig. 7(a) extractively shows the torsion spring 19 in the neutral position. Fig. 8(a) extractively shows the chuck section 11 in the neutral position.

As will be later described, as the roller 17 tilts in the clockwise direction of Fig. 3 when the orientation of the chuck section 11 is changed to orient its

distal end toward the bobbin stock section 8, the chuck tilting body 11a and returning 192 also tilt in the clockwise direction of Fig. 3 so that the one end 19a of the spring 19 is pivotally displaced in the clockwise direction. Thus, the distal end of the chuck section 11 is oriented horizontally leftward in Fig. 2 or 3, i.e. toward the bobbin stock section 8. Fig. 7(b) extractively shows the torsion spring 19 in this state, and Fig. 8(b) extractively shows the chuck section 11 in this state. Once a force acting on the roller 17 is removed, a clockwise pivotal displacing force acting on the one end 19a of the spring 19 is also removed so that the returning pin 192 moves counterclockwise back to the neutral position.

As will be later described, as the roller 17 tilts in the counterclockwise direction of Fig. 3 when the orientation of the chuck section 11 is changed to orient its distal end toward the rotary hook 6, the chuck tilting body 11a and returning 192 also tilt in the counterclockwise direction so that the other end 19b of the spring 19 is pivotally displaced in the counterclockwise direction. Thus, the distal end of the chuck section 11 is oriented horizontally rightward in Fig. 2 or 3, i.e. toward the rotary hook 6. Fig. 7(c) extractively shows the torsion spring 19 in this state, and Fig. 8(c) extractively shows the chuck section 11 in this state. Once a force acting on the roller 17 is removed, a counterclockwise pivotal displacing force acting on the other end 19b of the spring 19 is also removed so that the returning pin 192 moves clockwise back to the neutral position.

[Description about the Orientation Change Mechanisms 30 and 40]

Now, detailed constructions of the orientation change mechanisms 30 and 40 will be described with reference to Figs. 2, 3 and 9. Fig. 9 is a side view showing detailed constructions of the orientation change mechanisms 30 and 40, which schematically shows, for reference purposes, a movement

trajectory of the roller 17 during a series of orientation change operations.

The first orientation change mechanism 30 is located at an end portion, adjacent to the rotary hook 6, of the transfer stroke of the bobbin chuck unit 10 driven via the transfer mechanism 20 (guide rods 21 and 22). More specifically, the first orientation change mechanism 30 mainly comprises the first cam plate 31 of a predetermined shape as shown in Fig. 9. The first cam plate 31 has a cam surface 31a slanted downward toward its rear end (i.e., toward the rotary hook 6) over a predetermined tilting movement section of the transfer stroke, and it also has a horizontal groove 31b constituting a liner section of a predetermined length following the cam surface 31a. The first cam plate 31 also has a bearing section 31c supporting the rotation shaft of the above-mentioned driving belt gear 26. The horizontal groove 31b has a size suited to have the roller 17 of the bobbin chuck unit 10 fitted therein and to guide the roller 17 in the horizontal direction. Further, the horizontal groove 31b extends along a horizontal movement path of the tilting shaft 14 of the bobbin chuck unit 10 and also allows the shaft 14 to enter the groove 31b. The first cam plate 31 (first orientation change mechanism 30) is accurately positioned at a predetermined location on the underside of the main sewing table 3. The fastening member 24 located at one end of the guide rods 21 and 22 is readily mounted, via a screw or the like, to the thus accurately-positioned first cam plate 31.

The second orientation change mechanism 40 is located at an end portion, adjacent to the bobbin stock section 8, of the transfer stroke of the bobbin chuck unit 10 driven via the transfer mechanism 20 (guide rods 21 and 22). More specifically, the second orientation change mechanism 40 mainly comprises the second cam plate 41 of a predetermined shape as shown in Fig. 9. The second cam plate 41 is constructed in a substantially similar

manner to the first cam plate 31; more specifically, the second cam plate 41 is constructed in a symmetric relation to the first cam plate 31. Namely, the second cam plate 41 has a cam surface 41a slanted downward toward its front end (i.e., toward the bobbin stock section 8) over a predetermined tilting movement section of the transfer stroke, and it also has a horizontal groove 41b constituting a liner section of a predetermined length following the cam surface 41a. The second cam plate 41 also has a bearing section 41c supporting the rotation shaft of the above-mentioned driven belt gear 27. The second cam plate 41 (second orientation change mechanism 40) is accurately positioned and attached to a predetermined location on the underside of the extension sewing table 4 via a screw or the like. The fastening member 23 located at the other end of the guide rods 21 and 22 is readily mounted, via a screw or the like, to the thus accurately-positioned second cam plate 41. Thus, after the cam plates 31 and 41 have been accurately positioned and fixed to the undersides of the sewing tables 3 and 4, even where the elongated guide unit, comprising the guide rods 21 an 22 and fastening members 23 and 24, are removed as necessary, the accurately-positioned state can be maintained in and around the important orientation change mechanisms with no adverse influence on the mounting accuracy of the cam plates 31 and 41. Stated differently, even if the elongated guide unit, comprising the guide rods 21 and 22 and fastening members 23 and 24, are removed as necessary, the guide unit can be reattached to the cam plates 31 and 41 without the human operator giving any consideration to securement of reproducibility of the positioning accuracy of the orientation change mechanisms 30 and 40.

[Travel and Orientation Change of the Bobbin Chuck Unit 10]

The following paragraphs describe the orientation change, by the

orientation change mechanisms 30 and 40, of the bobbin chuck unit 10 with reference to Figs. 9 and 10 and other figures. Fig. 10 is a view schematically showing a movement trajectory of the chuck section 11 (chuck tilting body 11a) during a series of orientation change operations.

When the roller 17 of the bobbin chuck unit 10 is not approaching any of the cam plates 31 and 41 located at the opposite ends of the transfer stroke, the chuck section 11 is kept in the neutral position, through the aforementioned operation of the torsion spring 19, with the chuck mechanism at its distal end oriented downward, as illustrated in Figs. 2, 3, 8(a), etc. Such a section is indicated as a "neutral section" in Fig. 9. In this neutral position, the roller 17 is located in the uppermost position (see Fig. 7(a) and 8(a)), as set forth above. As the bobbin chuck unit 10 moves toward the rotary hook 6 (i.e., rightward in Figs. 2, 3, 9, etc.), the roller 17 is brought into abutment against the uppermost portion of the cam surface 31a of the first cam plate 31. Position where the roller 17 is located at that time is indicated in Fig. 9 by reference numeral 17a. As the bobbin chuck unit 10 further moves toward the rotary hook 6, the roller 17 tilts, about the tilting shaft 14, downward in the counterclockwise direction along the cam surface 31a extending rightwardly and downwardly, in response to which the tilting shaft actuating lever 16 and shaft 14 pivotally tilt in the same direction so that the chuck tilting body 11a tilts in the counterclockwise direction about the tilting shaft 14 and thus the chuck mechanism at the distal end of the chuck tilting body 11a gradually pivots upwardly in the counterclockwise direction so as to be oriented toward the rotary hook 6. After the roller 17 reaches the lowermost portion of the cam surface 31a, it moves horizontally while being kept fitted in the horizontal groove 31b. While the roller 17 is fitted in the horizontal groove 31b, the roller 17 is kept in a relationship with the moving

body 13 as shown in Fig. 7(c) and the chuck mechanism at the distal end of the chuck tilting body 11a is oriented horizontally rightward (i.e., toward the rotary hook 6) as shown in Fig. 8(c). Section over which the roller 17 moves horizontally while being kept fitted in the horizontal groove 31b is indicated in Fig. 9 as "linear section". In this "linear section", the chuck mechanism at the distal end of the chuck tilting body 11a further moves linearly rightward in an orientation facing the rotary hook 6 and ultimately reaches the rotary hook 6, so that it picks up a bobbin case B (in this case, the lower thread bobbin contained in the bobbin case B is normally empty) from the rotary hook 6 or places a bobbin B (in this case, the lower thread bobbin contained in the bobbin case B normally has a sufficient lower thread wound thereon) in the rotary hook 6. At the end of the "linear section", the tilting shaft 14 reaches a position indicated in Fig. 9 by reference numeral 14a.

Next, the above-mentioned motor is rotated in the reverse direction to cause the bobbin chuck unit 10 to travel in an opposite direction from the aforementioned direction (i.e., in a leftward direction in Fig. 9). If the roller 17 deviates from the horizontal groove 31b during the travel, the pin 192 is urged in the clockwise direction, by the biasing force of the torsion spring 19, so that the roller 17 moves upward in the clockwise direction along the cam surface 31a extending leftwardly and upwardly. When the roller 17 has deviated from the uppermost portion of the cam surface 31a, the chuck section 11 (chuck tilting body 11a) is brought to the neutral position (see Figs. 7(a) and 8(a)) as described above. Then, as the bobbin chuck unit 10 further moves toward the bobbin stock section 8 (i.e., leftward in Figs. 2, 3, 9, etc.), the roller 17 is brought into abutment against the uppermost portion of the cam surface 41a of the second cam plate 41. Position where the roller 17 is located at that time is indicated in Fig. 9 by reference numeral 17b. As the

bobbin chuck unit 10 further moves, the roller 17 tilts, about the tilting shaft 14, downward in the clockwise direction along the cam surface 41a extending leftwardly and downwardly, in response to which the tilting-shaft actuating lever 16 and shaft 14 pivotally tilt in the same direction so that the chuck tilting body 11a tilts in the clockwise direction about the tilting shaft 14 and thus the chuck mechanism at the distal end of the chuck tilting body 11a gradually pivots upwardly in the clockwise direction so as to be oriented toward the bobbin stock section 8. After the roller 17 reaches the lowermost portion of the cam surface 41a, it moves horizontally while being kept fitted in the horizontal groove 41b. While the roller 17 is fitted in the horizontal groove 41b, the roller 17 is kept in a relationship with the moving body 13 as shown in Fig. 7(b) and the chuck mechanism at the distal end of the chuck tilting body 11a is oriented horizontally leftward (i.e., toward the bobbin stock section 8) as shown in Fig. 8(b). Section over which the roller 17 moves horizontally while being kept fitted in the horizontal groove 41b is indicated in Fig. 9 as "linear section". In this "linear section", the chuck mechanism at the distal end of the chuck tilting body 11a further moves linearly leftward in an orientation facing the bobbin stock section 8 and ultimately reaches the bobbin stock section 8, so that it picks up a bobbin case B (in this case, the lower thread bobbin contained in the bobbin case B normally has a sufficient thread wound thereon) from the bobbin stock section 8 or places a bobbin B (in this case, the lower thread bobbin contained in the bobbin case B is normally empty) in the bobbin stock section 8. At the end of the "linear section", the tilting shaft 14 reaches a position indicated in Fig. 9 by reference numeral 14b.

Next, the above-mentioned motor is rotated in the forward direction to cause the bobbin chuck unit 10 to travel in the rightward direction in Fig. 9.

If the roller 17 deviates from the horizontal groove 41b during the travel, the pin 192 is urged in the counterclockwise direction, through the biasing force of the torsion spring 19, so that the roller 17 moves upward in the counterclockwise direction along the cam surface 41a extending rightwardly and upwardly. When the roller 17 has deviated from the uppermost portion of the cam surface 41a, the chuck section 11 (chuck tilting body 11a) is brought to the neutral position (see Figs. 7(a) and 8(a)) as described above.

In the above-described manner, the orientation of the chuck section 11 of the bobbin chuck unit 10 can be automatically changed within a range of 180 degrees depending on the transfer stroke.

[Description about the Chuck Mechanism]

Now, a description will be given about an embodiment of the chuck mechanism of the chuck section 11.

Fig. 11 is a top plan view of the chuck section 11 of the bobbin chuck unit 10, which particularly shows the distal end of the chuck section 11 contacting the rotary hook 6 in order to pick up a bobbin case B from the rotary hook 6 or immediately after a bobbin B has been placed in the rotary hook 6. Fig. 12 is a top plan view of the chuck section 11 grasping or holding a bobbin case B. Note that, although the bobbin case B and bobbin within the bobbin case B are generally shown in section in Figs. 11 and 12, illustration of hatchings is omitted.

The distal end of the chuck section 11 is formed as a posture retaining member 11b having a concavely-curved edge corresponding to a convexly-curved surface of the bobbin case B, and a bobbin-arm grasping claw 11c is pivotally supported on a predetermined portion of the distal end of the chuck section 11. Grasping-claw opening/closing lever 11d is pivotally supported on the same shaft as the bobbin-arm grasping claw 11c and at a

predetermined angle relative to the grasping claw 11c, and the grasping-claw opening/closing lever 11d is connected at its one end to a rod of a claw opening/closing lever 11e. The claw opening/closing lever 11e comprises, for example, an air cylinder; however, it may be any other actuator. As illustrated in Fig. 11, when the rod of the cylinder 11e is in a contracted position, the grasping claw 11c is kept in an opened position with no bobbin case B grasped thereby.

With reference to Fig. 11, a description will be given about how a bobbin case B is picked up from the rotary hook 6 by the chuck section 11. As seen in Fig. 11, when the chuck section 11 and rotary hook 6 are in a predetermined relationship for delivery/receipt of a bobbin case B between the chuck section 11 and the rotary hook 6, the distal end of the opened grasping claw 11c is snugly received in a claw inserting gap formed in a closed bobbin case arm B1 of the bobbin case B near the distal end of the arm B1. As the rod of the cylinder 11e is extended under such conditions, the grasping claw 11c pivots, about a pivot point, in the counterclockwise direction in the figure through a link structure between the grasping-claw opening/closing lever 11d and the grasping claw 11c. During that time, the distal end of the claw 11c in the claw inserting gap engages the inner surface of the bobbin case arm B1 to open the arm B1 outwardly. Arm support section 11g and arm window protrusion 11f are provided on predetermined portions of the posture retaining member 11b. The bobbin case arm B1 opened by the grasping claw 11c is supported by the arm support section 11g, and the arm window protrusion 11f is brought into tight engagement with an edge of an open window B2 formed in the bobbin case arm B1. In the aforementioned manner, the bobbin case arm B1 is grasped between the grasping claw 11c and the arm support section 11g, the arm window protrusion 11f is tightly

engaged with the edge of the open window B2 and the bobbin case B is firmly supported along its surface by the posture retaining member 11b, as shown in Fig. 12, as a result of which the bobbin case B as a whole can be firmly grasped by the chuck section 11. Although not shown, a helical spring is provided on the pivot of the grasping claw 11c for normally biasing the grasping claw 11c toward an opened position as shown in Fig. 11. Therefore, once a drive force for extending the cylinder 11e is removed, the grasping claw 11c returns to the opened position as shown in Fig. 11, to thereby release the bobbin case B having so far been grasped thereby. In the aforementioned manner, the grasp and release, by the chuck section 11, of the bobbin case B is controlled through control of the cylinder 11e.

[Explanation about the Bobbin Stock Section 8]

The bobbin stock section 8 may be constructed in the conventionally-known manner. As seen in Fig. 2 or 10, the bobbin stock section 8 includes four bobbin case stock positions extending radially and angularly spaced from one another at intervals of 90 degrees, and one of the stock positions is positioned, through rotation of an indexing drive shaft 81, at a predetermined take-in/take-out position 8a for access by the bobbin chuck unit 10. The indexing drive shaft 81 extends in a transverse direction of the sewing machine, as shown in Fig. 1, to perform indexing control on each of the bobbin stock positions in each of the bobbin changer apparatus 7 in the sewing machine. When, for example, an empty bobbin case B is to be received from the bobbin chuck unit 10, any one of the stock positions which is empty is positioned at the predetermined take-in/take-out position 8a. Bobbin case B having accommodated therein a bobbin with a sufficient lower thread wound thereon is set in advance at least one of the stock positions. Then, the bobbin stock section 8 receives, at the empty stock position

positioned at the predetermined take-in/take-out position 8a, the empty bobbin case B having been taken out and transferred from the rotary hook 6 by the bobbin chuck unit 10. After that, the indexing drive shaft 81 is rotated to turn the bobbin stock section 8 so that the stock position, where is pre-set the bobbin case B having accommodated therein a bobbin with a sufficient lower thread wound thereon, is positioned at the predetermined take-in/take-out position 8a. Then, the bobbin case B now positioned at the predetermined take-in/take-out position 8a is picked up by the bobbin chuck unit 10 and transferred to and placed in the rotary hook 6. In this way, the lower-thread-bobbin change can be carried out automatically. Generally, replenishment or resupply, to the bobbin stock section 8, of a new bobbin case B having accommodated therein a bobbin with a sufficient lower thread wound thereon and withdrawal of an empty bobbin case B are performed manually by the human operator. Therefore, that the bobbin stock section 8 is located on the front edge portion of the sewing table 4 means that manual operation to be performed by the human operator can be facilitated. However, the present invention is not so limited, and the resupply and withdrawal of bobbin cases B to and from the bobbin stock positions of the bobbin stock section 8 may be automatized as necessary.

[Explanation about Diassembly/Assembly Performance]

As noted above, the first cam plate 31, which is the first orientation change mechanism 30, can be accurately positioned and mounted to the underside of the main sewing table 3, while the second cam plate 41, which is the second orientation change mechanism 40, can be accurately positioned and mounted to the underside of the extension sewing table 4. Further, each of the bobbin stock sections 8 can be accurately positioned and mounted to the underside of the extension sewing table 4, as shown in Fig. 2. In this case, a

common mounting member 9, having bolt holes etc. accurately formed therein for mounting the cam plate 41 and bobbin stock section 8, can be accurately positioned and mounted to the underside of the extension sewing table 4 so that the cam plate 41 and bobbin stock section 8 are mounted to the common mounting member 9, as illustrated in Fig. 2.

In manufacture of the multi-head embroidery sewing machine in accordance with the instant embodiment of the present invention, the sewing machine may be manufactured, packed and transported to a predetermined delivery destination with at least the extension sewing table 4 detached from the body of the machine. Multi-head embroidery sewing machines of the present invention are large-size industrial machines, and many of them are shipped overseas. If such a multi-head embroidery sewing machine is packed and transported with the main sewing table (or machine-body-side sewing table) 3 and the extension sewing table 4 detached from each other and then, in an ultimate delivery destination, the multi-head embroidery sewing machine is assembled into a final product form by attaching the extension sewing table 4 to the main sewing table or machine-body-side sewing table 3, the overall package size can be reduced and the package can be stored efficiently in a shipping container, so that it is possible to significantly cut down on the overall shipping cost.

Advantages achievable by such detachable construction have been known so far. However, according to the conventionally-known techniques, the bobbin changer apparatus provided on the underside of the sewing table is integrated as a whole, and thus, when the main sewing table and extension sewing table are to be transported in mutually-detached form, the entire bobbin change apparatus too has to be detached from the body of the sewing machine for the transportation. In such a case, the entire bobbin change

apparatus has to be accurately positioned and mounted to the accurate position after the extension sewing table is reattached to the main sewing table, and these operations tend to be very cumbersome.

According to the instant embodiment of the present invention, on the other hand, not only the cam plate 41 and bobbin stock section 8 have already been accurately positioned and mounted to the extension sewing table but also the cam plate 31 has already been accurately positioned and mounted to the main sewing table 3 when manufacture of the sewing machine is completed in a factory. Further, the indexing drive shaft 8, which can belong to the side of the extension sewing table 4, may be mounted in advance to the extension sewing table 4, and the driven belt gear 27 too may be mounted in advance to the cam plate 41. Likewise, the driving belt gear 26 and driving gear 28, which can belong to the side of the main sewing table 3, may be mounted in advance to the cam plate 31, and the interlocking gear 29, common interlocking shaft 50, etc. too may be mounted in advance to the main sewing table 3. The multi-head embroidery sewing machine of the invention is packed and transported with the main sewing table 3 and extension sewing table 4 detached from each other, and then, in an ultimate delivery destination, the multi-head embroidery sewing machine is assembled into a final product form by attaching the extension sewing table 4 to the main sewing table or machine-body-side sewing table 3. In this case, a single unit, comprising the two guide rods 21 and 22 interconnected by the fastener members 23 and 24 and the bobbin chuck unit 10 equipped with the endless toothed belt 25 attached to the guide rods 21 and 22, is packed and transported separately; this means that a total of three packed units are transported in this case. Thus, in assembly of the bobbin changer apparatus 7, it is only necessary to readily mount the single unit to the cam plates 31

and 41 on the undersides of the sewing tables 3 and 4 by screwing or otherwise and then wind the belt 25 on the gears 26 and 27. Therefore, the bobbin changer apparatus 7 according to the instant embodiment can be assembled with utmost ease. As a result, it is possible to significantly cut down on the costs necessary for the separated packing, transporting and assemblying of the entire machine.

In addition to the merits achievable by the separated packing, transporting and assemblying of the entire sewing machine, the present invention can achieve other benefits by allowing the first and second orientation change mechanisms (cam plates 31 and 41) of the same construction to be used even when the transfer mechanism is constructed to be able to deal with any desired reciprocal traveling distances. Namely, even where the traveling amount of the bobbin grasping device differs depending on the depth (dimension in the front-rear direction) of the sewing tables, the present invention can appropriately with the differing traveling amount of the bobbin grasping device by just changing the length of the guide rods 21 and 22. As a result, the present invention can achieve the superior benefits that the necessary component parts can be made without requiring large amounts of time and labor (the same cam plates 31 and 41 can be shared) at relatively low cost, thereby achieving an easy-to-use bobbin changer apparatus with a general versatility.

[Explanation about Modifications]

Whereas, in the above-described embodiment, the first orientation change mechanism 30 associated with the rotary hook base 5 is mounted to the main sewing table 3, the present invention is not so limited, and the first orientation change mechanism 30 may be mounted to a suitable portion of the machine body side (e.g., to the rotary hook base 5). Fig. 13 shows a modified

example where the first orientation change mechanism 30 is mounted to the hook base 5. In Fig. 13, a bracket 301 of a substantial L shape is fixed to the hook base 5, and a lower end portion of the bracket 301 is fixed to a machine frame F. The first orientation change mechanism 30 associated with the rotary hook 5 is fixed to the bracket 301. The common interlocking shaft 50 is borne by the bracket 301. By the first orientation change mechanism 30 being mounted to the hook base 5 as noted above, the positioning accuracy of the bobbin chuck unit 10 on the side of the hook base 5 can be further enhanced.

Further, whereas, in the above-described embodiment, the claw 11c of the chuck section 11 of the bobbin chuck unit 10 is driven by an air cylinder, the present invention is not so limited, and the claw 11c of the chuck section 11 may be driven by any other suitable means. For example, the claw 11c of the chuck section 11 may be opened/closed by push/pull operation of a wire operatively connected to the claw 11c.

Further, in a power transmission mechanism for moving the bobbin chuck unit 10 through rotation of the interlocking shaft 50, there may be provided a slipping transmission mechanism which permits rotation of the common interlocking shaft 50 even when the bobbin chuck unit 10 is in a stationary or stopped state. For this purpose, two disks (not shown) may be fixed to ends of the respective shafts of the driving gear 28 and driving belt gear 26 and pressed against each other via spring members, so that the rotation of the driving gear 28 can be transmitted to the driving belt gear 26 through the disks resiliently pressed against each other. Thus, even when the driving belt gear 26 is brought into a non-rotatable state by the bobbin chuck unit 10 reaching a movement limit, the driving gear 28 and hence the common interlocking shaft 50 can be rotated by slipping action between the

two disks. Thus, in a case where a recess is formed in part of the front edge portion of the extension sewing table 4 so that the human operator can enter the recess and where the traveling amount of the bobbin chuck unit 10 differs between one bobbin changer unit 7 positioned where the recess is located and another bobbin changer unit 7 positioned where the recess is not located, for example, it is possible to drive the common interlocking shaft 50 to rotate in correspondence with one of the bobbin changer units 7 having the bobbin chuck unit 10 of the longer traveling amount. Namely, even if the common interlocking shaft 50 continues to be driven after the bobbin chuck unit 10 stops moving in the bobbin changer unit 7 having the bobbin chuck unit 10 of the shorter traveling amount, the above-mentioned slipping transmission mechanism prevents the rotation of the common interlocking shaft 50 from being transmitted, so that the linear movement of the bobbin chuck unit 10 of the shorter traveling amount is not allowed any longer. Further, even when there is a difference in the traveling operation of the bobbin chuck unit 10 between a plurality of the bobbin changer apparatus 7, the provision of the slipping transmission mechanism allows all of the bobbin chuck units 10 to travel to their movement limit positions by driving the common interlocking shaft 50 so that the bobbin chuck units 10 move more than actual traveling amounts.

Further, whereas, in the above-described embodiment, the common interlocking shaft 50 is driven by a motor, the present invention is not so limited, and the common interlocking shaft 50 may be driven by any other suitable means. For example, there may be employed a mechanism for converting a linear drive force of a linear drive source (e.g., air cylinder) into rotational motion of the common interlocking shaft 50.

Furthermore, the bobbin changer apparatus of the present invention

may be applied to any other types of sewing machines than embroidery sewing machines. Moreover, the bobbin changer apparatus of the present invention may be applied to single-head sewing machines or any other types of sewing machines than multi-head sewing machines.